



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

VIA ELECTRONIC MAIL

December 2, 2020

Glen Schultz
Project Coordinator
Waste Management, Inc.
100 Brandywine Blvd, Third Floor
Newtown, PA 18940

Re: **Review of the Report of Leachate Monitoring and Recommended Changes to the ELGE Remedy**
Operable Unit 1 – Keystone Sanitation Landfill Superfund Site, Union Twp., Adams Co., PA

Dear Mr. Schultz:

Provided in this letter are comments from EPA on the subject document ("Report") for the Keystone Sanitation Landfill Superfund Site (the "Site"), submitted by Golder Associates in conjunction with HydroGeologic, Inc. in April 2018 on behalf of the Owner/Operators. EPA also considered the split sampling results collected by Environmental Standards on behalf of the OGD and presented in a March 12, 2018 letter, and comments presented on the Report by Environmental Standards in a June 28, 2018 letter. The June 28 letter is included as an attachment to this letter.

In addition, the Fifth Five-Year Review, issued September 14, 2020, formally identified three issues related to the ELGE remedy. Because the findings and conclusions of the subject report are related to these issues, EPA feels it is helpful to continue to evaluate the work conducted in 2017 and 2018 by providing the Owner/Operators with comments from EPA and the OGD on the subject report. EPA intends to open discussions with the Owner/Operators into addressing those issues in the near future.

General Comments

1. The design infiltration rate of the soil cover is 2.2×10^{-6} cm/sec, which is equivalent to about 27 inches of precipitation annually. Has the actual infiltration rate on the upper portions of the landfill been measured, and if so, what was the measured rate?

Specific Comments

2. **Page 3, Section 2.2, Footnote**
In addition, it is noted here that EPA considered and approved the modification to the drilling method outlined in the approved Work Plan in an August 22, 2017 email message.
3. **Page 7, Section 2.4.3.1; Page 11, Section 3.2.1; Pages 11-12, Section 3.3**
Please forward to EPA copies of the field logs for well development and LMP/piezometer purging and field logs for sampling referenced in these sections.

4. **Page 11, Section 3.2.2**

Are sampling results available from the laboratory for other TCL VOCs, namely the TCL VOCs that are not leachate COCs but are groundwater COCs?

5. **Page 12, Section 3.3**

The purge rate for LMP-3(P) was reported as 200 mL/min in the second paragraph and 100 mL/min in the third paragraph. Please clarify the discrepancy.

6. **Page 14, Conclusions (First Conclusion)**

EPA disagrees with this conclusion. The intent of the LMPs is to monitor the effectiveness of individual ELGE wells at removing VOCs from the vadose zone so that migration into groundwater is prevented. The mounding of leachate in the southern portion of the landfill is not a standard for assessing that intent. EPA believes that the data generated from LMP installation and monitoring since the inception of the remedial action, including those data from four most recently installed LMPs, have been ineffective at evaluating the effectiveness of ELGE at preventing impacts to groundwater quality.

7. **Page 14, Conclusions (Second Conclusion, First Bullet – LMP-3 pair)**

The results in the LMP and piezometer appear consistent with EPA's interpretation of the CSM. However, these data should be paired with the ELGE or LFG well being monitored so that performance of the LFG can be assessed. In the future, it would be useful to compare these results to an LFG (e.g., LFG-10), even if the LFG is not subject to ELGE performance standards, strictly for the purposes of performing an evaluation as described in the previous comment.

8. **Page 14, Conclusions (Second Conclusion, Second Bullet – LMP-5 pair)**

Although the head levels are the same in LMP-3(M) and (P), the water quality results are different. Note that the reporting limits for cis-1,2-DCE, TCE, PCE, and vinyl chloride (leachate COCs) are all above the respective groundwater cleanup standards for those compounds in LMP-3(P). The reporting limit for vinyl chloride in LMP-3(M) is above its leachate performance standard.

Has the installation of an LMP at a different location within the radial influence of LFG-13 (other than LMP-5M) been considered? The presence of waste material below the water table is a concern for remedy performance. EPA notes that ELGE is not capable of treating nor intended to treat VOCs below the water table.

9. **Page 3, Section 2.1, general comment**

The laboratory analyses of the leachate samples [LMP-3(M) and LMP-5(M)] indicate that the suite of VOCs and the SVOC (1,4-dioxane) that are leaching into the water within the southern portion of the landfill are very similar to the contaminants detected in the associated piezometers and in the monitoring and extraction wells located along the perimeter of the landfill. The groundwater detected within the landfill at piezometer location LMP-6(P) is very similar in both contaminant composition and concentrations to the groundwater withdrawn at extraction wells EW-6 and K-3, which are down gradient of LMP-3(M) and LMP-5(M). These observations strongly support the interpretation that the landfill continues to act as a source of contamination to the underlying groundwater.

10. Page 15, Section 4.0, first paragraph

EPA disagrees that the LMP sampling results confirm a general absence of liquid in the waste, or with the premise that liquids found in the LMPs. The analytical results indicate that the liquids sampled from both LMPs and piezometers contain COCs and other hazardous substances consistent with landfill waste.

I look forward to receiving your responses and the revised memorandum within 30 days of receipt of this letter. As mentioned earlier, comments from the OGD on the report are attached to this letter. EPA recommends that the Owner/Operators review and address salient comments in the OGD letter. Many of the comments from EPA and the OGD overlap with issues identified in the Fifth Five-Year Review, including but not limited to the presence of 1,4-dioxane in leachate and the lack of source treatment or performance standards for the compound. If you have any questions, please feel free to contact me at (215) 814-3198 or sklaney.christopher@epa.gov.

Sincerely,

A handwritten signature in black ink, appearing to read 'Chris Sklaney', with a long horizontal flourish extending to the right.

Christopher Sklaney, RPM
Superfund & Emergency Management Division (3SD21)

Attachment: Technical Review of Golder Associates, Inc. and HydroGeologic, Inc. April 2018 Report
Leachate Monitoring Results and Recommended Changes to the ELGE Remedy

cc: Mindi Snoparsky, EPA
Jennifer Hubbard, EPA
Larry Smith, PADEP
Kevin Svitana, BSI

June 28, 2018

Mr. Christopher Sklaney
Remedial Project Manager
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1650 Arch Street (3HS21)
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**Subject: Technical Review of Golder Associates, Inc. and HydroGeoLogic, Inc.
April 2018 Report Leachate Monitoring Results and Recommended Changes
to the ELGE Remedy**

Dear Mr. Sklaney:

On May 2, 2018, Waste Management Disposal Services of Pennsylvania, Inc. (WMI) transmitted an April 2018 report on leachate monitoring at the Keystone Sanitation Landfill Superfund Site, located in Union Township, Adams County, Pennsylvania. The report titled "Leachate Monitoring Results and Recommended Changes to the ELGE Remedy" (April 2018 Report) was prepared for the benefit of WMI by Golder Associates Inc. (Golder) and HydroGeoLogic, Inc. (HGL) collectively, Golder-HGL.

On behalf of the Keystone Landfill Superfund Site Original Generator Defendants (OGDs), this letter responds to your request for our comments on the technical information provided in the April 2018 Golder-HGL Report.

As you know, from November 22, 2017, to December 13, 2017, Golder installed additional sampling points to evaluate leachate characteristics in the landfill. Based on the data collected during its 2017/2018 work, Golder-HGL developed the following three conclusions regarding leachate:

1. No measurable liquid was observed in four of the six leachate monitoring points, including LMP-1(M) and LMP-2(M) installed in 2002 and 2004, respectively. This indicates that no widespread, measurable leachate mounding is present in the southern portion of the landfill where the monitoring points have been installed. To further support this conclusion, observation of waste in the roto-sonic cores near the bottom of the landfill did not indicate saturated conditions.
2. Measurable liquid was present in two of the leachate monitoring points, LMP-3(M) and LMP-5(M).
 - a. At LMP-3(M), two leachate COCs were detected (tetrachloroethene and cis 1-2 dichloroethene) but were below their respective leachate performance standards, and all leachate COCs were not detected in the underlying groundwater at LMP-3(P).
 - b. At LMP-5(M), the water level is similar to the water level in the adjoining piezometer LMP-5(P), which is screened below the landfill in bedrock. These comparable water levels indicate groundwater is in contact with the waste at this location. Despite the presence of the water table in the waste, leachate COCs were not detected at LMP-5(M) or in the underlying groundwater.

3. The concentrations for the leachate COCs in groundwater samples obtained from LMP-3(P), LMP-4(P), and LMP-5(P) in January 2018 meet the [2000 ROD] groundwater performance standards. The concentrations for all four leachate COCs in the groundwater sample from LMP-6(P) exceeded the groundwater performance standards. However, leachate monitoring point LMP-6(M) was "dry" (insufficient liquid for sampling), and the depth to water in LMP-6(P) was 34.55 feet below the bottom of waste at this location. Since there is no measurable leachate present at the bottom of the waste at this location, it can be reasonably concluded that the concentrations of leachate COCs above the groundwater performance standards in LMP-6(P) may be the result of residual contamination already present within the aquifer rather than from ongoing leachate migrating downward from the waste.

We have assessed the technical merits of each conclusion and have determined that (1) leachate exists in the landfill and contains very high concentrations of numerous chemicals that continue to adversely impact Site groundwater quality; (2) a specific standard for 1,4-dioxane in leachate is needed and (3) additional study to better characterize the nature and distribution of leachate within the landfill is necessary. Our analysis supporting these conclusions is provided below.

I. GOLDER-HGL CONCLUSION 1 – LIQUID OBSERVATIONS IN LEACHATE MONITORING POINTS

A licensed Environmental Standards Professional Geologist (PG) collected split samples at the same time Golder's field team collected the samples from the newly installed sampling points. Table 1 below provides field-measured data for each Leachate Monitoring Pair (LMP). A suffix "M" indicates the sampling point was intended to intercept leachate. The suffix "P" indicates that the sampling point is intended to intercept groundwater.

Table 1: LMP Liquid Level Measurements

Well ID	Depth to Liquid (feet below monitoring point)	Well Depth (feet below monitoring point)	Liquid Thickness (feet)
LMP-3M	52.63	54.5	1.87
LMP-3P	74.8	92	17.2
LMP-4M	Dry	39	NA
LMP-4P	69.14	73	3.86
LMP-5M	34.53	43	8.47
LMP-5P	34.55	57	22.45
LMP-6M	Dry	38.5	NA
LMP-6P	73.39	80	6.61

Note: Sample point depths were taken from well construction logs and were not verified in the field.

As shown in the table above, while two of the newly installed leachate sampling points were dry, Golder-HGL confirmed the presence of leachate in at least two areas of the landfill (LMP-3, 1.87 feet of leachate; and LMP-5, 8.47 feet of leachate). While virtually all municipal landfills contain leachate to some degree, having nearly 8 1/2 feet of leachate is an unusually thick accumulation. Moreover, both areas where leachate was detected are interpreted as being in the lowest elevations of landfill waste, an area that has not been well characterized.

The detection of considerable leachate thicknesses at two sampling points indicates that, although not ubiquitous, leachate is present in the landfill. In view of the limited number of monitoring points, the extent of leachate has not been defined and requires further assessment. Because the locations where leachate is present (LMP-3 and LMP-5) also had the thickest waste intervals, and the elevation at the base of the waste at these locations (752.2 feet MSL for LMP-3 and 754.5 MSL for LMP-5) represent the lowest elevations at which wastes occur in the landfill, additional leachate monitoring points situated at locations where the bottom of waste is below 754 feet MSL are likely needed to determine the nature and extent of leachate at the Site.

Golder-HGL reported that roto-sonic cores collected from the base of the landfill did not exhibit saturated conditions, and, on that basis, concluded that leachate was not widespread at the Site. Recovered cores, however, are not always indicative of whether there are fluids that will eventually accumulate in the subsurface. This is evident from the fact that these "dry" conditions were noted in the Record of Borehole figures for LMP-3 and LMP-5 presented in Appendix A of the Golder-HGL report, even though after a period of time, significant thicknesses of fluids for sampling was found in both boreholes.

Far from demonstrating the absence of widespread leachate, the detections of significant leachate in LMP-3 and LMP-5 suggests that the conceptual model for leachate occurrence has not been fully developed. There are simply insufficient "LMP(M)" data points to fully understand the relationship between the base of the waste, waste thickness, and accumulation of leachate.

II. GOLDER-HGL CONCLUSION 2 -- LEACHATE COC CHARACTERISTICS AND LIQUID LEVELS

At two leachate monitoring locations, LMP- 3(M), and LMP-5(M), both piezometers and leachate monitoring points contained liquid. ^{1/} Each of these landfill locations are examined individually below.

A. Landfill Monitoring Couplet LMP 3

Hydraulically, the groundwater elevation at piezometer LMP-3(P) is more than 22 feet below the leachate elevation measured in adjacent LMP-3(M). This marked difference in groundwater and leachate elevation indicates that the two points are monitoring two distinct units -- a leachate unit and a groundwater unit. Examination of liquid chemistry in the LMP-3 couplet further illustrates that leachate and groundwater are separately monitored at this location. Based on Golder-HGL's Leachate Report, Table 5 (on the following page), Environmental Standards notes marked differences in liquid chemistry.

In the case of 1,4-Dioxane, the leachate sample from LMP-3(M) contains more than 20-times the chemical than in the underlying groundwater. Moreover, cis 1,2-dichloroethene and tetrachloroethene, are detected in the leachate, but are not identified in groundwater at concentrations above the laboratory reporting limit in the paired Golder-HGL groundwater sample. ^{2/}

Importantly, there is a dramatic difference in other chemical parameters at this couplet. Biochemical oxygen and chemical oxygen demands, chloride, sulfate and total organic carbon values are two orders of magnitude or higher in the leachate sample than in the groundwater sample. This is further evidence that the two points are monitoring separate types of liquid.

^{1.} A comparison of the chemical data reported by Golder-HGL and Environmental Standards' laboratories is supplied in Table 2. This table shows that the two laboratories identified comparable chemical suites at similar concentrations suggesting that the chemical data upon which this discussion is based is sufficiently accurate and precise for our discussion.

^{2.} As shown on Table 2, these compounds were identified in the Environmental Standards-split samples albeit at estimated concentrations.

Based on both liquid levels and chemical data, leachate is present in the landfill at the LMP-3 location. As noted by the OGDs in the past, through vertical seepage (i.e., gravitational forces), this leachate is eventually transported and contaminates the groundwater beneath the landfill. Even a small pocket of source material leaching to groundwater will adversely impact groundwater quality.

	LMP-3(M) 1/18/2018 Leachate	LMP-3(P) 1/18/2018 Groundwater
Parameter	Result	Result
Volatle Organic		
1,4-Dioxane	82	4.7
cis-1,2-Dichloroethene	46	ND
Tetrachloroethene	4.4	ND
Trichloroethene	ND	ND
Vinyl Chloride	ND	ND
General Chemistry		
Alkalinity, Total	3560	84.7
Ammonia	190	0.35
Biochemical Oxygen De	>744.13	6.7
Chemical Oxygen	22600	10
Chloride	8330	12.3
pH	6.2	7
Phosphorus	0.37	0.31
Sulfate	500	5
Sulfide	1	1
Temperature	21.9	22.2
Total Organic Carbon	5200	3.6
Total Suspended Solids	50.8	224

The presence of 1,4-dioxane at a concentration of 82 µg/L in the leachate is of concern. No performance standard in leachate has been set for 1,4-dioxane, a non-volatile chemical that was not addressed in the original leachate remedial performance criteria established in the September 2000 Keystone Landfill Superfund Site Amended Record of Decision.

The boring log from LMP-3(M) also provides an indication that the waste is of variable (i.e., unpredictable) content and is likely the primary source of VOCs in groundwater. The Golder drilling log (attached) indicates that the PID detected very high (greater than 1,000 ppm) organic vapor concentrations at this location from 20 to 28 feet below the land surface (approximately 784 to 776 ft msl). At no other location, so far, has such high-strength VOC material been found in the landfill. The PID VOC values demonstrate that high-concentration VOCs are in the waste mass, that they are difficult to find (i.e., randomly dispersed in the landfill)

and that the leachate detected in this area may be the source of the increased chemical concentrations observed since the start-up of pumping from the recently converted recovery well K-3. These findings again suggest a need for additional leachate monitoring points and additional study.

B. Landfill Monitoring Couplet LMP-5

Groundwater and leachate also were recovered from monitoring couplet LMP-5. While the liquid elevations are similar, the difference in chemistry provides evidence that both leachate and groundwater are present at this location in the landfill. In the case of 1,4-Dioxane, the leachate sample from LMP-5(M) contains more than twice the concentration of 1,4-dioxane when compared to underlying groundwater (LMP-5(P)). As in the case of the LMP-3 landfill location, there is also a marked difference in many of the leachate parameter values at this couplet. Biochemical oxygen and chemical oxygen demands, sulfate and total organic carbon values are at least an order of magnitude higher in the leachate sample than in the groundwater sample. Based on the chemical data, leachate is present in the landfill at the LMP-5 location.

In leachate monitoring point LMP-5(M), 1,4-dioxane was detected at a concentration of 270 µg/L, the highest concentrations ever detected at the site for this chemical. The resulting groundwater concentration (130 µg/L) is more than 20-times the performance standards established by US EPA in its September 2015 Explanation of Significant Difference (2015 ESD).

The high concentration of 1,4 dioxane in both the leachate and in groundwater at the LMP-5 couplet may, in part, be explained by the lack of influence from the Gas Extraction System Radius of Influence, and the lower vapor pressure of 1,4-dioxane. Based on 2014 Frey Engineering work, attached is an overlay of the approximated Radius of Influences (ROIs) of gas extraction points relative to the two new leachate monitoring points containing landfill leachate (Figure 1). As shown, the ROI of the current gas

extraction system does not reach the location of the LMP-5 couplet, and barely reaches the LMP-3 couplet. This figure demonstrates that the existing gas collection system is *not* reaching some areas of the landfill where leachate is now known to exist. This also happens to be the area beneath which the most persistent, and highest concentration chemicals remain in groundwater.

The presence of 1,4-dioxane in leachate (at a historical maximum in LMP-5[M]), and the presence of 1,4-dioxane in groundwater beneath LMP-5(M) suggests that leachate is an ongoing, uncontrolled source of 1,4-dioxane to groundwater (particularly in K-3 and MW-EI) and that additional leachate control and a leachate standard for 1,4-Dioxane is needed to address an ongoing 1,4-dioxane groundwater source.

	LMP-5(M) 1/17/2018 Leachate	LMP-5(P) 1/17/2018 Groundwater
Parameter	Result	Result
Volatile Organic		
1,4-Dioxane	270	130
cis-1,2-Dichloroethene	ND	ND
Tetrachloroethene	ND	ND
Trichloroethene	ND	ND
Vinyl Chloride	ND	ND
General Chemistry		
Alkalinity, Total	3200	1690
Ammonia	66.5	368
Biochemical Oxygen De	>581.87	368
Chemical Oxygen	12100	1010
Chloride	7920	8940
pH	6.6	6.9
Phosphorus	0.24	0.42
Sulfate	35.8	5
Sulfide	1	1
Temperature	21.9	21.9
Total Organic Carbon	3850	298
Total Suspended Solids	542	175

With the above as background, the fact that groundwater elevations and leachate elevations are comparable at LMP-5 is more likely than not a function of poorly understood landfill hydraulics (or monitoring well construction problems). Table 3 of the Golder-HGL study reports liquid level elevations for LMP-5 (M) at 768.16 feet MSL and for LMP-5 (P) at 768.34 feet MSL, respectively.

These elevations appear to be anomalous when compared to the neighboring couplet's piezometers. Leachate monitoring probes LMP-3(P) and LMP-6(P), which are comparable to LMP-5 (M), have water surface elevations 731.72 and 725.05 feet MSL, respectively. This would indicate a somewhat unlikely difference in water table elevations of more than 30 feet between monitoring points

that are within 300 to 400 feet of one another. A groundwater gradient of 0.1 is very unlikely in these situations and Golder-LHG should explore the cause of these differences. The relationship between leachate accumulation and depth becomes very clear when illustrated as in Figure 2, attached.

III. GOLDER-HGL CONCLUSION 3 – WHY COCS ARE PRESENT ABOVE GROUNDWATER PERFORMANCE STANDARDS

A. Residual Contamination in the Aquifer

Golder-HGL asserts that "...it can be reasonably concluded that the concentrations of leachate COCs above the groundwater performance standards in LMP-6(P) may be the result of residual contamination already present within the aquifer rather than from ongoing leachate migrating downward from the waste." (Golder, 2018). While theoretically, it may be possible for "back-diffusion" of chemicals from aquifer fractures to occur, Golder-HGL only speculates that this is the case and does not offer any site-specific proof that this is happening. Indeed, Golder-HGL's conclusion is not scientifically defensible given the analysis provided above and how poorly the distribution of leachate at the Keystone Landfill is understood.

Moreover, Golder-HGL's "groundwater is contaminating the landfill" conclusion is further contradicted by the leachate's variable chemical content. If contamination in the leachate were derived from underlying groundwater, one would expect the VOC concentrations in landfill gas to be relatively uniform as vapor dispersion usually results in a chemical suite that would be far more similar than what is observed. To the contrary, Golder-HGL's data show that leachate contains no detectable cis-1,2-DCE in LMP-5 but 46 µg/L

of the same compound in LMP-3. Similarly, while tetrachloroethene was not detected in LMP-5; it was identified in LMP-3 at 4.4 µg/L. These highly-variable concentrations among sampling locations suggests that the primary source of vapor contamination is the waste, not groundwater.

The data collected by Golder-HGL demonstrate that adjustments to the Conceptual Site Model are appropriate. Examining the Golder-HGL information, we now understand that:

1. Leachate is present in the landfill.
2. The leachate exists in discontinuous perched zones of "high-strength" liquid.
3. The specific location of all the perched leachate "pockets" is unknown.
4. Each perched leachate zone is likely of distinct chemistry, at times containing target VOCs, at other times not, but having common leachate characteristics such as high COD, sulfate and BOD concentrations.
5. Chemicals within the leachate are reaching groundwater underlying the landfill.
6. The chemicals migrating via gravity are degrading groundwater quality beneath the landfill.

Both LMP-1(M) and, LMP-2(M) have a screen elevation well above the leachate encountered in LMP-3(M) and LMP-5(M). LMP-1(M) and, LMP-2(M) are historically reported by Golder to be "dry" of leachate and may be so because (1) they were installed well-above an elevation where leachate is generated and accumulates or (2) they "missed" the perched leachate exists because the leachate pockets in certain areas are of limited areal extent. Either explanation is consistent with the revised conceptual model. Leachate monitoring points LMP-3(M) and LMP5(M) are installed at elevations below the other leachate monitoring points, suggesting that the leachate at the landfill favors those areas of the waste mass where the waste is at its deepest.

Perched leachate zones are not uncommon at municipal solid waste (MSW) landfills. Waste settlement, as well as consolidation phenomena, can cause a decrease in the waste permeability. This can lead to a reduction in the conveyance of the leachate to a drainage system (here, we have none). It is, therefore, possible that a so-called perched leachate zone will form. Such a zone is constituted by an area in the body of the landfill where the leachate is temporarily trapped and is unable to infiltrate downward or laterally. This phenomenon is influenced by many factors, which include rain infiltration rate, waste moisture and composition, landfill height, and so on (DiTrapani, 2015).

B. Golder-HGL Proposed ELGE Remedy Modification

The remainder of the Golder-HGL report develops the framework and background for Golder-HGL's strategy of modifying the ELGE remedy and the performance criteria that Waste Management and US EPA agreed upon as detailed in the Amended 2000 Record of Decision (2000 ROD). While the OGDs were not a signatory to the Consent Decree that implemented that amended ROD, the effectiveness of the OGD groundwater remedy is contingent upon the way landfill remediation efforts are managed. As a result, we have several comments on the modifications suggested by Golder-HGL.

First, we disagree with the Golder-HGL statement that "The sampling results, therefore, support a conceptual model that leachate is not an ongoing source of the leachate COCs to groundwater and that there is an ongoing source of these COCs within the aquifer." (Golder, 2018). As explained above, our interpretation of the Golder-HGL data is contrary to this hypothesis. Based on our review of available data, we conclude that perched leachate exists in the landfill, that the specific location of these perched leachate "pockets" is not fully known, and that the leachate's variable chemical content contradicts Golder-HGL's hypothesis and renders it highly speculative.

Second, we reject Golder-HGL's hypothesis that "some of the vapors extracted by the ELGE may originate as groundwater contamination (caused by contaminant mass that is already in groundwater) that is off-gassing into the unsaturated zone." Despite extensive literature research, Environmental Standards could not find a single technical reference (peer-reviewed or otherwise) that documents contamination of a municipal landfill from underlying groundwater sources; the opposite, however, is very well documented and is a component of virtually every chemical fate and transport conceptual site model reviewed. See, e.g., AD Little, 1996; Becker, 2002; Bjerg, 2014; Cozzarelli et al., 2000; US EPA, 2015.

Third, existing leachate performance standards were based on specific volatile chemical concentrations calculated to be protective of a hypothetical groundwater user downgradient of the landfill boundary. Until those criteria can be demonstrated to be met in the leachate throughout the landfill, modifying the remedy in a manner favorable to the landfill owner, and to the detriment of groundwater quality, is unreasonable. Even Golder-HGL agrees that leachate is present in the landfill and that the location of the leachate is difficult to predict. The conceptual site model now suggests that in many respects, the source of groundwater contamination is poorly understood. Until the leachate distribution and the chemical variability of the leachate is better understood, there is no basis for modifying the ELGE performance criteria.

Finally, the ELGE remedy was designed and approved by US EPA to remediate leachate and other landfill gasses with respect to VOCs. The chemical 1,4 dioxane, added by US EPA to the list of chemicals requiring groundwater cleanup, is not a VOC. As part of its 2015, ESD, US EPA noted that 1,4-dioxane is being added to the groundwater remediation performance standards at this site, because "In the early 2000s, EPA became aware that 1,4-dioxane, an organic compound used as a stabilizer in organic solvents and degreasers, was often present at sites, such as this one." Nevertheless, US EPA did not require a 1,4-dioxane source evaluation of the landfill or the attending leachate with respect to this compound. The data provided by Golder-HGL and confirmed by independent laboratory tests undertaken by Environmental Standards now indicates that the source of 1,4-dioxane is landfill leachate. 1,4-dioxane must be evaluated, a leachate standard must be developed, and an appropriate remedial technology must be selected for remediation of 1,4-dioxane in the landfill.

IV. CONCLUSIONS AND RECOMMENDATIONS

Golder-HGL's interpretation of their newly acquired data is inconsistent with the site data, our professional experience at landfills and the documentation available in the scientific literature. After 20 years of ELGE operation, it appears that the current ELGE technology is having a positive, but very limited, impact on the sources of groundwater contamination in the landfill. The presence of leachate at the lowest portions of the landfill waste (Figure 2) and beyond the ROI of landfill gas points (Figure 1), the identification of unusually high VOC zones in one of the LMP borings (attached), the persistence of chemicals in groundwater, and a non-VOC (1,4-dioxane) that has now been named a site COC all suggest that additional investigation work by Golder is warranted.

This is consistent with US EPA's approach when it approved installation of limited additional leachate monitoring points. In its June 17, 2017, Leachate Monitoring Work Plan approval letter, EPA expressly states that "EPA will assess the applicability of additional LMP/piezometer locations after implementation of the Work Plan and review of future data." The newly collected data demonstrates that additional study is required.

We recommend that the additional investigation be focused on better defining leachate locations, understanding leachate chemistry, and improving the ROI coverage of the ELGE/landfill gas recovery system.

As an initial step, we recommend that Golder investigate the chemistry, elevations, thicknesses, and the geometry of liquids that Golder reports to be present in the landfill gas and leachate monitoring points. As shown on Table 3 of Golder's 2017 Annual ELGE monitoring report (attached), 13 out of 15 gas monitoring points (GMPs) and one leachate monitoring point contained liquids. It is possible that these liquids are "leachate" rather than "condensate" as Golder has hypothesized in the past. Analysis of these liquids may help project stakeholders better understand the liquids in the landfill and would, at a minimum, inform future decisions as to the location of additional leachate monitoring points.

Finally, the presence of a non-VOC; 1,4-dioxane, in leachate (at a historical maximum in LMP-5[M]), and the presence of 1,4-dioxane in groundwater beneath LMP-5(M) suggests that US EPA will need to develop and adopt a leachate standard for 1,4-dioxane to address an ongoing 1,4-dioxane leachate source. We recommend that US EPA require the development of a leachate performance standard for 1,4-dioxane, and, based on that standard, consider whether and what additional leachate remediation measures are warranted.

Thank you for affording us the opportunity to provide comment on Golder-HGL's report. If you have comments or questions about our analysis, please feel free to contact Gerry Kirkpatrick at 434.293.4039, gkirkpatrick@envstd.com. Alternatively, you can contact Kevin Svitana at (614) 329-2036 or by emailing Kevin.Svitana@bsigroup.com.

Respectfully,

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Mr. J. McBurney
Original Generator Defendants

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Table 2
Leachate Monitoring Point and Groundwater Sample Analytical Results Keystone Landfill Superfund Site
Union Township, Adams County, Pennsylvania

Parameter	LMP-3(M) 1/18/2018 Leachate		LMP-3(P) 1/18/2018 Groundwater		LMP-4(P) 1/18/2018 Groundwater		LMP-5(M) 1/17/2018 Leachate		LMP-5(P) 1/17/2018 Groundwater		LMP-6(P) 1/18/2018 Groundwater	
	Golden Result	ENVSTD Result	Golden Result	ENVSTD Result	Golden Result	ENVSTD Result	Golden Result	ENVSTD Result	Golden Result	ENVSTD Result	Golden Result	ENVSTD Result
Volatile Organic Compounds (ug/L)												
1,4-Dioxane	8.2	17	4.7	1.1	270	100.0	270	110.00	130	25	6.1	13
cis-1,2-Dichloroethene	46	36	ND	0.35 (J)	1.2	1.1	ND	17.00	ND	ND	66	54
Tetrachloroethene	4.4	4.2	ND	1	ND	0.24 (J)	ND	0.35 (J)	ND	ND	14	11
Trichloroethene	ND	1.1	ND	0.33 (J)	ND	0.027 (J)	ND	0.97 (J)	ND	ND	16	12
Vinyl Chloride	ND	1.9 (J)	ND	0.13 (J)	ND	0.35 (J)	ND	9.9	ND	ND	23	20
General Chemistry (mg/L)												
Alkalinity, Total	3560	4400	84.7	68.9	42.1	45.3	1700	4240	1690	1610	826	775.00
Ammonia	190	162	0.35	0.28 (J)	2.1	2.2	66.5	674	368	331	49.8	31.00
Biochemical Oxygen Demand	>744.13	8700	6.7	ND	3.4	ND	>681.87	6930	368	417	>90.5	541.00
Chemical Oxygen Demand	27800	12700	10	4.7 (J)	10	19.7	12100	11300	1010	600	694	1070
Chloride	8330	11000	12.3	12.7	424	573.0	7920	10000	8940	2940	1270	1710
pH	6.20	6.18	7.00	6.69	5.7	5.4	6.6	6.55	6.9	7.18	6.4	6.19
Phosphorus	0.37	0.06	0.31	0.47	0.081	0.056	0.74	0.12	0.42	0.27	0.29	0.28
Sulfate	580	676	5	2	5	2.6	35.8	23.4	5	3	5	2.22
Sulfide	1	ND	1	ND	1	ND	1	3.3	1	ND	1	ND
Temperature	21.0	NR	22.2	NR	22.1	NR	21.9	NR	21.9	NR	22.7	NR
Total Organic Carbon	5200	3540	3.6	3.0	4.5	5.1	3850	4380	298	359.0	403	426
Total Suspended Solids	50.8	247.0	224	555	476	61.3	542	210	175	135	30	15.4

Notes

NR -- parameter value not recorded
 ND -- chemical was not detected at a concentration above laboratory Reporting Limit
 For Golden Sample Qualifiers, refer to Table 5 of the April 2018 Golden Leachate Report
 For Environmental Standards qualifiers, refer to Environmental Standards to Chris Sidney Dated March 12, 2018
 (J) Indicates that quantitation is estimated
 > Indicates that the demand exceeds laboratory instrumentation quantitation limits
 Analytes not analyzed by both parties are excluded from this table.

Figure 1
Estimated Landfill Gas Extraction Coverage at South Portion of Landfill

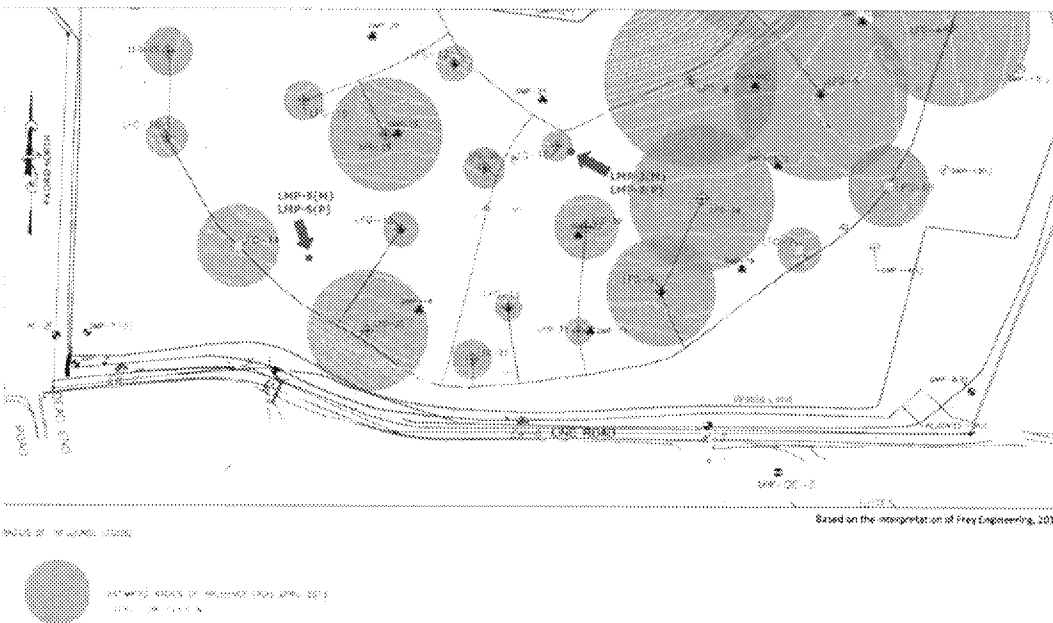
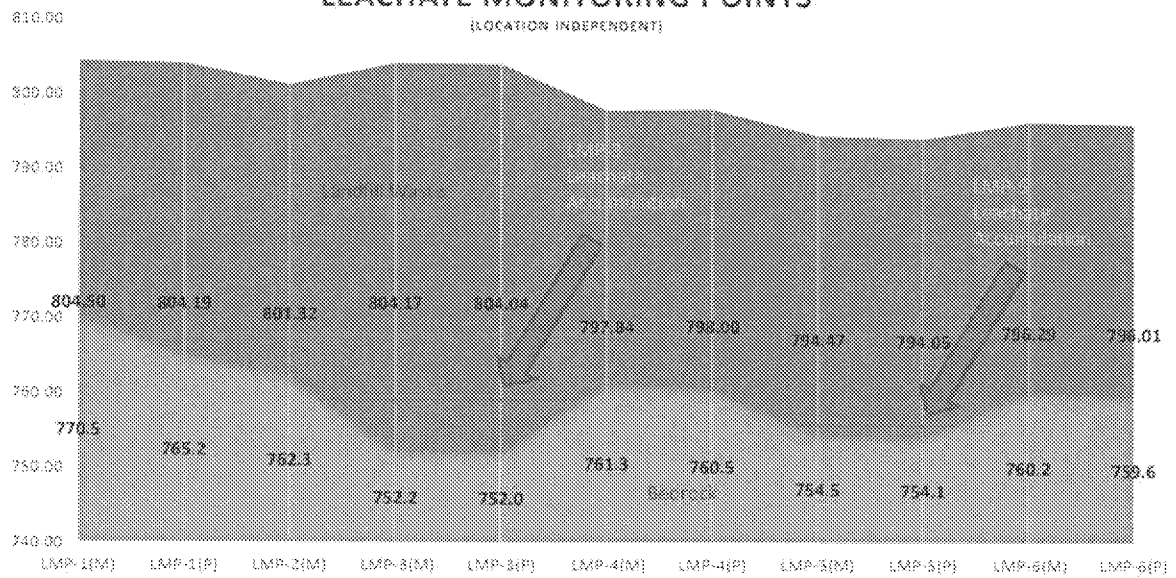


FIGURE 2
LEACHATE MONITORING POINTS
 (LOCATION INDEPENDENT)



SHEET 1 of 2

INCLINATION: -90
DEPTH W.L.: 52.5 ft
ELEVATION W.L.: 754.1 ft
DATE W.L.: 12/21/17
TIME W.L.: 4:25 pm

Log continued on next page

**Golder
Associates**

March 2018

973-6407

TABLE 3
FIELD MONITORING DATA - SEPTEMBER 2017
ENHANCED LANDFILL GAS EXTRACTION SYSTEM PERFORMANCE MONITORING
KEYSTONE SANITATION LANDFILL
UNION TOWNSHIP, ADAMS COUNTY, PENNSYLVANIA

Sample Location	Date (mm/dd/yy)	Well Depth (ft-bmp)	Depth-to-Water (ft-bmp)	Depth of Liquid (ft)	Gas Volume Purged (Liters)	Purge Connection	CH4 (%)	CO2 (%)	O2 (%)	Balance Gas (%)	PID Reading (ppm)	Comments
LFG-1	09/28/17	29.85	29.25	0.60	Note 5	1/4" Barb	NM	NM	NM	NM	6.1	-
LFG-5	09/28/17	49.70	49.70	0.00	Note 5	1/4" Barb	NM	NM	NM	NM	6.5	-
LFG-6R	09/28/17	52.60	50.85	1.75	Note 5	1/4" Barb	NM	NM	NM	NM	30.0	-
LFG-7	09/28/17	32.69	32.69	0.00	Note 5	1/4" Barb	NM	NM	NM	NM	10.1	-
LFG-9	09/28/17	35.96	33.89	2.07	Note 5	1/4" Barb	NM	NM	NM	NM	16.7	-
LFG-11	09/28/17	37.63	37.25	0.38	Note 5	1/4" Barb	NM	NM	NM	NM	91.5	-
LFG-12	09/28/17	35.01	32.60	2.41	Note 5	1/4" Barb	NM	NM	NM	NM	10.8	-
LFG-13	09/28/17	33.68	33.12	0.56	Note 5	1/4" Barb	NM	NM	NM	NM	28.2	-
LFG-14	09/28/17	34.10	33.38	0.72	Note 5	1/4" Barb	NM	NM	NM	NM	1.2	-
GMP-9	09/28/17	27.53	26.49	1.04	25	Swagelok	NM	NM	NM	NM	0.3	-
GMP-10	09/28/17	25.20	24.76	0.44	25	Swagelok	NM	NM	NM	NM	3.4	-
GMP-15	09/28/17	26.21	22.70	3.51	25	Swagelok	NM	NM	NM	NM	1.0	-
GMP-16	09/28/17	25.52	24.86	0.66	25	Swagelok	NM	NM	NM	NM	2.9	-
GMP-17	09/28/17	22.84	19.24	3.60	25	Swagelok	NM	NM	NM	NM	3.5	-
GMP-18	09/28/17	NM	NM	NM	-	Swagelok	NM	NM	NM	NM	NM	Wasp Nest
GMP-19	09/28/17	36.65	36.11	0.54	25	Swagelok	NM	NM	NM	NM	170.3	-
GMP-20	09/28/17	24.09	19.73	4.36	25	Swagelok	NM	NM	NM	NM	3.2	-
GMP-21	09/28/17	26.48	28.36	0.12	25	Swagelok	NM	NM	NM	NM	2.6	-
GMP-22	09/28/17	27.93	27.43	0.50	25	Swagelok	NM	NM	NM	NM	21.5	-
GMP-23	09/28/17	17.80	17.44	0.36	25	Swagelok	NM	NM	NM	NM	3.8	-
GMP-24	09/28/17	34.12	29.06	5.06	25	Swagelok	NM	NM	NM	NM	1.4	-
GMP-25	09/28/17	17.54	16.16	1.38	25	Swagelok	NM	NM	NM	NM	2.0	-
LMP-1(M)	09/28/17	39.49	39.25	0.14	100	Swagelok	NM	NM	NM	NM	2.7	-
LMP-1(P)	09/28/17	52.10	50.32	1.78	25	Swagelok	NM	NM	NM	NM	0.2	-
LMP-2(M)	09/28/17	36.15	36.15	0.00	100	Swagelok	NM	NM	NM	NM	0.0	-
Flare (sample#1)	09/28/17					1/4" Barb	NM	NM	NM	NM	NM	-
Flare (sample#2)	09/28/17					1/4" Barb	NM	NM	NM	NM	8.1	-

Notes:

- 1) BMP - Below measuring point
- 2) NA - Not applicable
- 3) 1/4" Barb - Operating gas extraction well sampled through the lowest sample port on the well head assembly.
- 4) Swagelok - Well purged and sampled through quick connect fitting on top of the dedicated well cap.
- 5) LFG gas wells not purged; flare system running and system was under negative pressure.

Prepared by: FTA 3/22/2018
 Checked by: MTW 3/23/2018